

REMARKS

Claims 1, 3, 6-7, and 10 are pending in the present application. No claims have been amended, added, or canceled, leaving Claims 1, 3, 6-7, and 10 for further consideration in the present response.

Reconsideration and allowance of the claims is respectfully requested in view of the following remarks.

Claim Rejections Under 35 U.S.C. § 103

Claims 1, 3, 6-7, and 10 stand rejected under 35 U.S.C. § 103(a), as allegedly being unpatentable over any one of U.S. Patent No. 6,489,616 to Giedd (“Giedd”) and U.S. Patent No. 4,144,634 to Chang *et al.* (“Chang”) and further in view of U.S. Patent No. 3,135,638 to Cheney *et al.* (“Cheney”), U.S. Patent No. 3,193,418 to Cooper *et al.* (“Cooper”), and U.S. Patent No. 6,344,966 to Monden *et al.* (“Monden”). Applicants respectfully traverse these rejections.

The present claims are directed to a method of cleaning a semiconductor material surface of a partially manufactured integrated circuit. The present inventors have discovered that a non-aqueous organic solvent unexpectedly removes dopant ions from a surface of a partially manufactured integrated circuit.

Independent claim 1 requires, *inter alia*, that the non-aqueous organic solvent be selected from the group consisting of methyl ethyl ketone, cyclohexanone, methyl isoamyl ketone, 2-heptanone, polyhydric alcohols, cyclic ethers and esters, and mixtures thereof. Dependent claim 7 requires heating the semiconductor material surface and removing an increased amount of dopant ions relative to not heating the semiconductor material surface. Dependent claim 10 requires coating the semiconductor material surface prior to formation of a barrier layer on the semiconductor material surface. Applicants respectfully submit that the cited prior art fails to disclose (i) using a non-aqueous organic solvent to remove dopant ions subsequent to implantation; (ii) heating the semiconductor material surface; and (iii) coating the semiconductor material surface prior to formation of a barrier layer.

For an obviousness rejection to be proper, the Examiner must meet the burden of

establishing a *prima facie* case of obviousness. *In re Fine*, 5 U.S.P.Q.2d 1596, 1598 (Fed. Cir. 1988). It has long been recognized that establishing a *prima facie* case of obviousness requires that all elements of the invention be disclosed in the prior art. *In re Wilson*, 165 U.S.P.Q. 494, 496 (C.C.P.A. 1970). Moreover, in *KSR Int'l Co. v. Teleflex Inc.*, the Supreme Court recently found that it remains legally insufficient to conclude that a claim is obvious “merely by demonstrating that each element was, independently, known in the prior art.” *KSR Int'l Co. v. Teleflex Inc.*, 127 S. Ct. 1731 (2007). The Court stated that it is also important for the Examiner to “identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements in the way the claimed new invention does.” *Id.* Additionally, the Court indicated that “this analysis should be made explicit.” *Id.*

Giedd fails to disclose a non-aqueous organic solvent as required by the present claims. Giedd is directed to an uncooled, infrared detector which includes a sensor having an amorphous surface layer containing organic carbon and a high dopant concentration.

(Abstract) Giedd discloses

After the implantation process is complete, typically most or essentially all of the target dopant layer is either diffused into the polymer layer or sputtered off the polymer layer surface. Any dopant which remains may be removed by means common in the art. For example, because the dopant is below the surface of the sensor (e.g., typically about 25 angstroms, 50 angstroms or more), the surface can be cleaned with a solvent (e.g., an acetone solution) without disturbing the amorphous layer of the sensor.

(Col. 16, ll. 3-11) Giedd expressly discloses that the solvent is “an acetone solution” and is common to the art. Giedd thus appears to disclose an aqueous solution of acetone. This view is buttressed by the additional art cited by the Examiner since all the cited references disclose aqueous solutions. In addition, Giedd is completely silent as to heating the surface as well as to coating the surface prior to formation of a barrier layer as required by claims 7 and 10, respectively. Applicants respectfully submit that Giedd cannot render the present claims obvious because Giedd fails to disclose all the limitations required by the claims.

Chang fails to disclose removing dopant ions with a non-aqueous organic solvent. Chang is directed to fabricating gallium arsenide MOS devices. (Abstract) Chang discloses

cleaning an epitaxially grown GaAs containing dopants using trichloroethylene, acetone, and alcohol. (Col. 5, ll. 41-44) Moreover, Chang in no way suggests the limitation in claim 1 that the semiconductor material surface is coated with the non-aqueous organic solvent subsequent to implantation of dopant ions into the surface. In addition, Giedd is completely silent as to heating the surface as well as to coating the surface prior to formation of a barrier layer as required by claims 7 and 10, respectively. Applicants respectfully submit that Chang fails to disclose all the limitations of the present claims and therefore cannot render the present claims obvious.

Cheney, Cooper, and Monden all fail to remedy the deficiencies of Giedd and Chang. Specifically, all three references disclose using solvents to remove unincorporated or unpolymerized material following polymerization or unwanted polymerized material rather than using a non-aqueous solvent to remove dopant ions subsequent to implantation as required by the present claims.

Cheney and Cooper are directed to semiconductor fabrication. (Cheney, Col. 1, ll. 10-12; Cooper, Col. 1, ll. 10-12) Both disclose forming a film of photosensitive polymerizable (PSP) material, such as polyvinyl alcohol, on the surface of a germanium layer. (Cheney, Col. 2, line 71 to Col. 3, line 4; Cooper, Col. 3, ll. 25-30) Both disclose using a solvent such as methyl ethyl ketone to remove unpolymerized PSP material. (Cheney, Col. 3, ll. 15-20; Cooper, Col. 1, ll. 41-44) Both further disclose that “the PSP material 36 is next removed by softening with an appropriate solvent, such as methyl ethyl ketone, acetone, or trichloroethylene, and subsequent brushing, to expose the germanium film 34 in stripes as shown in FIG. 9.” (Cheney, Col. 3, ll. 35-37; Cooper, Col. 3, ll. 61-65) The selectively polymerized material then serves as a pattern for subsequent fabrication. The semiconductor device is further fabricated to include a pattern of SiO₂ stripes that serve as a mask during a subsequent boron diffusion process. (Cheney, Col. 3, line 70 to Col. 4, line 7; Cooper, Col. 3, ll. 61-65) Therefore, Cooper and Cheney disclose using organic solvents to remove unpolymerized and polymerized organic material and fail to disclose removal of dopant ions. Further, Cooper and Cheney disclose washing **prior** to dopant implantation rather than **subsequent** to implantation as required by the present claims. Applicants respectfully submit

that Cooper and Cheney fail to remedy the deficiencies of Giedd and Chang and therefore cannot render the present claims obvious.

Monden is directed to a solid electrolytic capacitor comprising, *inter alia*, a solid electrolyte layer having an electrically conducting polymer composition layer containing as a dopant a particular organic anion. (Abstract) Monden discloses:

The production method of the solid electrolyte according to the present invention is characterized in that the above-described organic anion or a combination of it with another anion is contained as the dopant for the polymer of the polymerizable monomer compound. More specifically, the present invention relates to a production method comprising a step of causing oxidative polymerization of a polymerizable monomer compound represented by general formulae (III) or (IV) on a finely porous dielectric layer **in the presence of a compound capable of providing the above-described organic anion by the action of an oxidizing agent**, the polymer produced working out to a solid electrolyte on the dielectric surface.

(Col. 13, ll. 16-31) (emphasis added) Thus, Monden discloses polymerization in the presence of certain organic anions that provide the dopant. Accordingly, Monden fails to disclose implantation of dopant ions into a surface. While Monden discloses a coating operation (Col. 13, ll. 54-55), Monden discloses washing the completed solid electrolyte after production (Col. 13, ll. 60-62) rather than washing a partially manufactured integrated circuit. Monden further discloses that

[A]ny solvent may be used as far as it can merely dissolve the polymerizable monomer compound, the above-described organic anion or the compound providing another anion having a dopant ability. By the washing with the solvent, the amount of the dopant other than the above-described organic anion, contained in the polymer may be reduced.

(Col. 13, line 65 to Col. 14, line 4) Therefore, Monden discloses the solvent removes organic compounds rather than dopant ions. Monden also suggests that the solvent may remove dopants other than the organic anion that are contained in the polymer. Thus, Monden teaches away from using a solvent to remove dopant ions from a surface of a material as that may cause removal of dopants within the material.

Finally, Monden discloses a list of suitable solvents including ketones such as acetone and methyl ethyl ketone. (Col. 19, ll. 24-38). The preferred solvents are “water, an alcohol, a

ketone and/or a combination system thereof.” (Col. 19, ll. 38-39) Therefore, the preferred solvents include aqueous solvents.

Applicants respectfully submit that the cited prior art fails to disclose all the limitations of the present claims. At best, the cited prior art only shows that acetone and ethyl methyl ketone are both solvents used in semiconductor fabrication. Thus, the prior art is relevant, if at all, only to one of the claimed solvents, and wholly fails to disclose all the claim limitations. Specifically, the cited art, whether taken singly or in combination, fails to disclose (i) using a non-aqueous organic solvent to remove dopant ions subsequent to implantation (Claim 1); (ii) heating the semiconductor material surface (Claim 7); and (iii) coating the semiconductor material surface prior to formation of a barrier layer (Claim 10).

The obviousness inquiry also requires consideration of common knowledge and common sense. *KSR*, 127 S. Ct. at 1742-43; *DyStar Textilfarben GmbH & Co. Deutschland KG v. C.H. Patrick Co.*, 464 F.3d 1356, 1367 (Fed. Cir. 2006) (“Our suggestion test is in actuality quite flexible and not only permits, but requires, consideration of common knowledge and common sense.”) “A patent composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art.” *KSR*, 127 S. Ct. at 1741. To find obviousness, the Examiner must “identify a reason that would have prompted a person of ordinary skill in the art in the relevant field to combine the elements in the way the claimed new invention does.” *Id.*

Applicants respectfully submit that the cited art discloses using organic solvents to remove organic materials. One of ordinary skill in the art using reasonable common knowledge common sense would not be motivated to use a non-aqueous organic solvent to remove a non-organic dopant ion. The present inventors have found that exposing the wafer to the non-aqueous organic solvent was unexpectedly effective in removing dopant ions from undesired areas of the semiconductor surface. (¶ [0020]). It was wholly unexpected that photoresist solvents normally employed during the manufacture of integrated circuits would be effective in removing dopant ions. The unexpected nature of this discovery is bolstered by the fact that these solvents were used for the removal of PSP materials for such a long period of time. Prior to the present inventors’ discovery, one of ordinary skill in the art would not

assume that a non-aqueous organic solvent would effectively remove dopant ions from a semiconductor surface.

In view of the foregoing, independent Claim 1 and dependent Claims 3, 6-7, and 10, which depend therefrom, are not rendered obvious in view of the cited art. Applicants therefore respectfully request the withdrawal of the 35 U.S.C. § 103(a) rejections of these claims.

It is believed that the foregoing remarks fully comply with the Office Action and that the claims herein should now be allowable to Applicants. Accordingly, reconsideration and allowance is requested.

If there are any additional charges with respect to this Response or otherwise, please charge them to Deposit Account No. 09-0458 maintained by Assignee.

Respectfully submitted,

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